Assessment of Ergot and Blind Seed Diseases of Grasses in the Willamette Valley of Oregon

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ABSTRACT

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The levels of ergot and blind seed among grasses grown for seed in the Willamette Valley of Oregon between 1986 and 1989 were assessed. Seed samples, representing nine grass species, were obtained from the Oregon State University Seed Laboratory (seed lab) or, in 1988 and 1989, were collected from commercial fields before harvest. Grower management information was obtained for 179 and 218 fields in 1988 and 1989, respectively. The correlation coefficient between seed lab samples and field samples with ergot in 1988 and 1989 was 0.90 and 0.61, respectively. Ergot was observed in 2–34% of the colonial bentgrass, creeping bentgrass, Kentucky bluegrass, and chewing festuca seed samples examined. Significantly ($P = 0.05$) more samples infested with ergot were observed in 1988 than in 1989. The percentage of ergot in burned and nonburned fields was similar in 1988 and 1989, and the incidence ranged from 4 to 11%. The correlation coefficient between seed lab samples and field samples with blind seed in 1988 and 1989 was 0.90 and 0.91, respectively. Blind seed was detected in 8–10% of the tall fescue and in 2–3% of the perennial ryegrass seed samples examined. Blind seed was detected in 38% of fields open burned and 0% of fields not burned in 1988. In 1989, 6% of the fields open burned and 4% of the fields not burned contained blind seed.

Additional keywords: disease survey, seed production

Forage grass seed production is a major industry in the Pacific Northwest, and the Willamette Valley of Oregon in particular. Ergot, caused by *Claviceps purpurea* (Fr.:Fr.) Tul., and blind seed, caused by *Gloeotinia temulenta* (Prill & Delacr.) M. Wilson, M. Noble, & E. Gray, are important diseases that affect the flowers of forage grasses.

In Oregon, blind seed was first reported in 1944 (5) and, at that time, the disease was considered a serious threat to the seed industry (7). Evaluation of control measures between 1940 and 1948 revealed that field burning was an effective means of controlling blind seed in perennial ryegrass (*Lolium perenne* L.) (6). Blind seed incidence in perennial ryegrass in relation to field burning was monitored by Hardison (9) between 1944 and 1979. Assessments were based on samples submitted to the Oregon State University Seed Laboratory. Between 1966 and 1979, 12% or fewer fields had trace levels of blind seed (9). No comparisons were made of blind seed among burned and nonburned fields.

The practice of field burning has continued to date; it is currently strictly regulated by legislative action, which is a result of public pressure against the practice. Hectarage of grass burned has declined in recent years. The impact of a reduction or ban on field burning is not well understood, and an efficient means of monitoring levels of blind seed is needed. Seed testing has been based on samples collected from the field before harvest (1,10,12) or postharvest samples submitted to a seed testing facility (7). Field-collected samples are limited by a short period of time between flowering and seed maturity and by a large labor force needed to collect and process samples. Seed lab samples are cleaned before submission and may not reflect actual disease levels present in a field. The degree of association between seed lab and field samples has not been determined. In addition, the use of seed lab records for assessment of ergot within Oregon has not been investigated.

The objectives of this study were to assess the incidence of blind seed and ergot among a wider range of grass species and cultivars than previously assessed, based on seed lab samples, and compare these data with those collected from field surveys.

MATERIALS AND METHODS

Preliminary surveys of blind seed and ergot in Oregon, based on sampling of commercial fields before harvest, were conducted in 1988 (1) and 1989. In 1988, 26–30% of the annual (*L. multiflorum* Lam.) and perennial ryegrass and tall fescue (*Festuca arundinacea* Schreb.) fields contained blind seed, although the disease was present at low levels (less than one in 300 seeds affected). In 1989, fewer than 19% of the tall fescue or perennial ryegrass fields contained blind seed. Ergot was observed in 52, 13, or 3% of the Kentucky bluegrass (*Poa pratensis* L.), colonial bentgrass (*Agrostis tenuis* Sibth.), and chewing festuca (*F. rubra* L. var. *commutata* Gaudin) fields, respectively, sampled in 1988. In 1989, ergot was detected in 6, 13, and 8% of the sampled Kentucky bluegrass, bentgrass, and chewing festuca fields, respectively. The 1989 survey was similar to the one conducted in 1988 except that the number of fields of colonial bentgrass, Kentucky bluegrass, chewing festuca, tall fescue, annual ryegrass, perennial ryegrass, and orchardgrass fields sampled were 38, 34, 71, 130, 25, 63, and 78, respectively.

Seed samples were obtained from the Oregon State University Seed Laboratory. Four years (1986–1989) of samples were available for testing. Grasses included in the survey were colonial bentgrass, creeping bentgrass (*A. palustris* Huds.), Kentucky bluegrass, chewing festuca, red fescue (*F. rubra* L.), tall fescue, annual ryegrass, perennial ryegrass, and orchardgrass (*Dactylis glomerata* L.). Up to 52 samples of each cultivar were randomly selected and requested from the seed lab. Samples were examined for blind seed as described by Hardison (6), except that seed were soaked in distilled water, drained, and the suspension was centrifuged at 4,700 rpm (492 rad/s) for 10 min. The pellet was resuspended in 1 ml of water.

Ergot in seed lab samples was assessed by querying the seed laboratory's data base. Samples containing ergot were reported in the inert category of the purity test, which is required for seed certification. Ergot incidence for each cultivar assessed was based on the total samples of that cultivar included in the data base for a given year.

Incidence of ergot and blind seed data, based on preharvest samples collected from commercial seed production fields, were obtained from surveys I conducted during 1988 and 1989. Results of these surveys were based on three subsamples

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from each seed lot collected from each field. Seed lab samples, processed for blind seed as described by Hardison (6), included one sample per lot. For consistency of comparisons, only the first subsample of the field survey data was used for correlation analysis. Correlations were established between incidence within cultivars examined in the field survey and incidence within corresponding samples of the same cultivars from the seed lab.

During the fall of 1988 and 1989, growers of fields sampled in the field surveys were queried for management information. Growers were asked if the selected fields were open burned (4), propane burned (4), not burned, or newly planted. Information was obtained for 179 and 218 fields in 1988 and 1989, respectively.

Spearman's rank correlation analysis (15) was used to compare rankings between years of cultivars of Kentucky bluegrass or tall fescue and ergot incidence. Comparisons of ergot between any 2 yr were made using a paired comparison analysis with significance based on a *t* test (16). Data from cultivars were pooled to obtain means for species.

RESULTS

Blind seed was observed in 12 of 20 cultivars representing six species tested between 1986 and 1989 (Table 1). Blind seed was not detected in red fescue, orchardgrass, or annual ryegrass. Blind seed incidence from 1986 to 1989 was 5–10% and 2–3% in tall fescue and perennial ryegrass samples, respectively (Table 2). Blind seed incidence among colonial bentgrass, creeping bentgrass, Kentucky bluegrass, and chewing festuca ranged from 0 to 3%.

Ergot was observed in 28 of 40 cultivars tested representing seven species (Table 1). Two to 34% ergot incidence was detected in colonial bentgrass, creeping bentgrass, Kentucky bluegrass, and chewing festuca samples (Table 2). Four percent or less ergot was detected in tall fescue, red fescue, and orchardgrass samples. Ergot was not observed in annual and perennial ryegrass. Spearman's rank correlations for ranked incidence of ergot among cultivars of Kentucky bluegrass were significant for the comparison of 1987 and 1989 and in the 4-yr averages for 1987 and 1989 (Table 3). Rank correlations for tall fescue were significant for the comparison of 4-yr averages with 1986 and 1987 (Table 3). Ergot incidence was not significantly different ($P = 0.05$) between 1986 and 1987, 1987 and 1988, or 1986 and 1988 but was significantly greater in 1988 compared with 1989 (Table 4).

Correlation coefficients, representing the association between percent seed lab and percent field samples with blind seed, were 0.90 and 0.91 in 1988 and 1989, respectively (significant at $P = 0.01$) (Fig. 1). Correlation coefficients representing the association between percent seed lab and percent field samples with ergot were 0.90 (significant at $P = 0.01$) and 0.61 (not significant at $P = 0.05$) in 1988 and 1989, respectively (Fig. 2).

In 1988, blind seed was detected in 38% of the fields open burned and 0% of the

Table 1. Incidence[a] of blind seed and ergot diseases in samples submitted to the Oregon State University Seed Laboratory between 1986 and 1989

Host and cultivar	Blind seed				Ergot			
	1986	1987	1988	1989	1986	1987	1988	1989
Colonial bentgrass								
Highland	...	0/51	1/49	0/42	24/160	14/153	35/118	20/132
Creeping bentgrass	...							
Penncross	...	0/38	0/50	0/50	22/93	13/95	18/113	13/105
Penneagle	...	0/39	1/51	0/50	6/46	6/46	11/74	13/68
Seaside	...	...	...	...	7/31	6/38	6/31	12/45
Kentucky bluegrass								
Merit	0/43	0/35	0/47	0/50	18/36	14/67	9/89	5/81
Newport	...	...	...	...	0/17	4/18	8/19	2/12
Nassau	...	...	...	...	8/50	2/30	0/17	1/8
Columbia	...	...	...	...	4/17	6/14	6/18	7/19
Park	...	...	...	...	0/17	0/18	1/25	0/25
Baron	0/51	0/23	1/50	1/50	4/56	4/60	6/50	3/59
Parade	...	...	...	...	4/29	4/29	1/20	2/18
Rugby	...	...	...	...	6/32	9/27	3/29	2/18
Tall fescue								
Apache	...	...	...	...	2/52	0/47	2/72	0/67
Bonanza	...	0/41	0/51	1/52	0/84	1/91	0/115	1/145
Falcon	...	0/31	2/49	2/48	3/139	0/117	2/134	0/123
Fawn	3/23	5/28	9/51	13/52	1/131	1/127	6/119	3/121
Forager	1/18	1/28	5/50	3/49	1/76	1/98	3/93	0/49
Johnstone	...	...	...	...	0/28	0/39	3/36	0/46
Jaguar	...	...	...	...	2/49	1/57	1/41	0/36
Mustang	...	...	...	...	1/100	1/105	1/74	0/79
Olympic	...	...	...	...	0/76	0/46	1/63	0/64
Rebel II	...	...	...	...	0/19	1/65	0/112	1/161
Tempo	...	...	...	...	1/18	1/27	0/21	0/23
Red fescue								
Pennlawn	...	0/19	0/20	0/18	1/38	1/23	1/28	0/26
Chewing festuca								
Cascade	...	0/46	2/51	0/51	2/127	33/138	5/128	3/112
Koket	...	0/18	1/52	1/52	1/42	29/45	8/66	3/57
Orchardgrass								
Hallmark	...	...	0/49	0/50	0/75	2/71	1/76	0/57
Potomac	...	0/18	0/51	0/47	0/173	2/172	4/149	1/114
Annual ryegrass								
Aubade	...	...	...	...	0/13	0/46	0/13	0/13
Marshall	...	0/45	0/52	0/38	0/79	0/61	0/62	0/38
Tetrone	...	...	...	...	0/61	0/14	0/19	0/8
Waseaoba	...	...	...	...	0/38	0/17	0/16	0/12
Waseyutaka	...	...	...	...	0/51	0/23	0/31	0/37
Perennial ryegrass								
Birdie II	3/47	...	...	0/23	0/54	0/42	0/38	0/24
Citation II	0/48	0/20	0/51	0/50	0/76	0/76	0/103	0/111
Linn	1/50	2/51	2/51	3/52	0/406	0/450	0/370	0/239
Omega II	1/48	0/14	0/47	0/38	0/63	0/52	0/47	0/41
Palmer	...	...	...	...	0/29	0/29	0/39	0/42
Pennant	...	...	...	...	0/31	0/46	0/99	0/85
Pennfine	0/48	0/41	0/50	0/52	0/87	0/70	0/99	0/108

[a] The number of samples positive for blind seed or ergot over the number examined.

Table 2. Incidence of blind seed and ergot among various grasses grown for seed in Oregon between 1986 and 1989

Grass species	Blind seed (%)				Ergot (%)			
	1986	1987	1988	1989	1986	1987	1988	1989
Colonial bentgrass	...	0	2	0	15	9	30	15
Creeping bentgrass	...	0	1	0	21	14	16	17
Kentucky bluegrass	0	0	1	1	17	16	13	9
Tall fescue	10	5	8	9	1	1	2	1
Red fescue	...	0	0	0	3	4	4	0
Chewing festuca	...	0	3	1	2	34	7	4
Orchardgrass	...	0	0	0	0	2	2	1
Annual ryegrass	...	0	0	0	0	0	0	0
Perennial ryegrass	3	3	2	2	0	0	0	0

Table 3. Spearman's rank correlation coefficients for the ranked incidence of ergot among cultivars of tall fescue or Kentucky bluegrass and between years

	Kentucky bluegrass				Tall fescue			
Year	1987	1988	1989	4-yr average[a]	1987	1988	1989	4-yr average[a]
1986	0.548	0.012	0.274	0.458	0.341	0.034	−0.091	0.561*
1987	...	0.667	0.714*	0.970*[b]	...	−0.411	0.452	0.573*
1988	...	...	0.423	0.685	...	...	0.114	0.318
1989	...	...	...	0.815*	...	...	...	0.377

[a] Four-year average of ranked correlation coefficients.
[b] * = Significant at $P = 0.05$.

Table 4. Probability of significant difference in ergot incidence between two given years, based on paired *t* test

Year	1987	1988	1989
1986	0.512	0.771	0.652
1987	...	0.083	0.746
1988	...	...	0.964

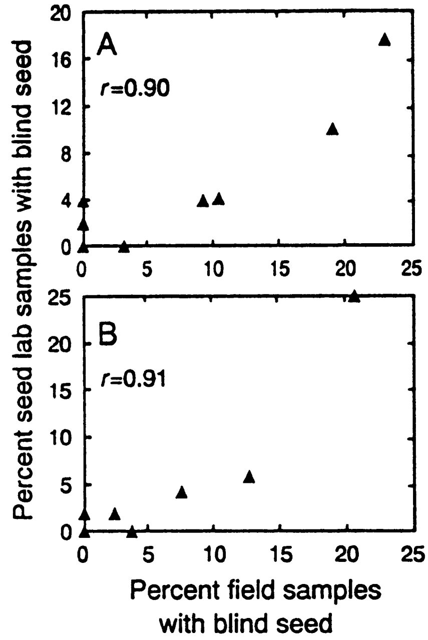

Fig. 1. Correlation between percent seed lab samples and percent field samples with blind seed in **(A)** 1988 and **(B)** 1989.

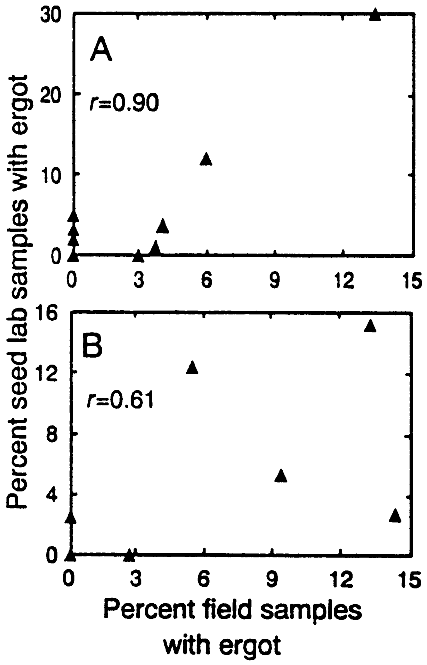

Fig. 2. Correlation between percent seed lab samples and percent field samples with ergot in **(A)** 1988 and **(B)** 1989.

fields not burned (Table 5). In 1989, 6% of the fields open burned and 4% of the fields not burned contained blind seed. The percentage of ergot in burned and nonburned fields was similar in 1988 and 1989 and the incidence ranged from 4 to 11%.

DISCUSSION

The incidence of blind seed in field samples was correlated with blind seed levels detected in seed lab samples. Higher levels of blind seed were reported in the previously published field survey for 1988 (1), but results were based on three subsamples per field. Blind seed incidences within the field samples were at or near the levels of detection, and the most heavily infested sample encountered had only one in 300 seed infected. Thus, either field or seed lab samples appear to be suitable sources for detecting low levels of blind seed.

Blind seed can have a significant impact on seed germination. Previous studies documented the relationship between the amount of infestation of blind seed and reductions in germination of perennial ryegrass (2,3,6,14). The incidence of blind seed detected in 1986 to 1989 was below that needed to notably affect germination.

Blind seed was not observed in annual ryegrass, although the species is susceptible to *G. temulenta* (8). Unlike perennial ryegrass, annual ryegrass fields are replanted each year. Hardison (6) demonstrated that plowing and planting seeds at a depth of 1.25 cm or greater was effective in controlling blind seed. Thus, little or no blind seed would be expected under such a cultural practice.

The very low incidence of blind seed observed in crops such as perennial ryegrass suggests that the amount detected may represent a background level. Blind seed detection in ryegrass growing as a weed grass was also at a low level (1). Blind seed was not observed in orchardgrass, consistent with the classification of orchardgrass as not susceptible to *G. temulenta* (8).

The proportion of samples containing ergot ranged from 5 to 8% between 1986 and 1989. Ergot was most frequently observed in colonial bentgrass, creeping bentgrass, and Kentucky bluegrass. Ergot was not recorded for annual ryegrass and perennial ryegrass samples. Both species are susceptible to ergot, and it is not clear why ergot is absent from these species.

Ergot in seed lab samples was correlated with ergot in field samples, suggesting that seed lab records may be an important resource in monitoring the levels of ergot in the Willamette Valley. Ergot detection in the field survey was based on the detection of sclerotia in any of 400 seed heads collected from each field (1). Ergot in seed lab samples was recorded if a single sclerotium was observed during the inspection of a representative seed sample during a purity test. Thus, the sensitivity of detection among field samples is one in 400 seed heads. The lack of a significant correlation between field and seed lab samples in 1989 may have been attributable to a low incidence of ergot in that year. However, annual examination of seed lab records would provide an efficient means of detecting increasing levels of ergot.

Less ergot and blind seed occurred in 1989 than 1988. Variation in ergot and blind seed among grass species and cultivars can be expected depending on yearly variation in environmental conditions at the time of flowering. Infection of grasses by *C. purpurea* and *G. temulenta* is favored by environmental conditions, including rain at the time of flowering (2,11,13).

Little difference in ergot among fields burned and not burned was observed. Levels of ergot among burned and nonburned fields may reflect a general distribution of ergot within the Willamette Valley. Ergot is widely distributed among commercial fields and weed grasses in the area (1).

A high incidence of blind seed was observed in open burned fields in 1989 and none in nonburned fields. This was unexpected, although field burning has not been reported to eradicate *G. temulenta* from infested fields (5,6). A very low incidence of blind seed would be expected in infested, burned fields. It is not clear why the disease was undetected in nonburned fields. Additional studies are needed to determine the yearly variation in blind seed among treatments.

This study suggests that seed lab samples and records may represent an efficient means of monitoring blind seed and ergot levels in Oregon. Conidia of *G. temulenta* remain intact when dried and can be detected on seed samples stored

Table 5. Percentage of fields with ergot or blind seed under various management treatments in 1988 and 1989

	1988			1989		
Management treatment	**Total fields**	**Ergot (%)**	**Blind seed (%)**	**Total fields**	**Ergot (%)**	**Blind seed (%)**
Open burned	93	11	38	115	4	6
Propane burned	31	0	6	31	0	3
Not burned	29	7	0	52	4	4
Newly planted	26	4	4	20	0	5

for years. Convenience, low cost, and a range of samples, representing all of the major grass species grown for seed in the Willamette Valley, make seed lab samples an important resource in monitoring ergot and blind seed disease levels.

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LITERATURE CITED

1. Alderman, S. C. 1988. Distribution of *Gloeotinia temulenta*, *Claviceps purpurea*, and *Anguina agrostis* among grasses in the Willamette Valley of Oregon in 1988. J. Appl. Seed Prod. 6:6-10.
2. Calvert, E. L., and Muskett, A. E. 1945. Blind-seed disease of rye-grass (*Phialea temulenta* Prill & Delacr.). Ann. Appl. Biol. 32:329-343.
3. Chestnutt, D. M. B. 1958. Susceptibility of perennial ryegrass to blind seed disease (*Gloeotinia temulenta*). J. Br. Grassl. Soc. 13:275-278.
4. Conklin, F. S., Young, W. C., III, and Youngberg, H. W. 1989. Burning grass seed fields in Oregon's Willamette Valley: The search for solutions. Oreg. State Univ. Ext. Misc. Bull. 8397. 68 pp.
5. Fischer, G. W. 1944. The blind-seed disease of ryegrass (*Lolium* spp.) in Oregon. Phytopathology 34:934-935.
6. Hardison, J. R. 1948. Field control of blind seed disease of perennial ryegrass in Oregon. Phytopathology 38:404-419.
7. Hardison, J. R. 1957. Record of blind seed disease control in Oregon. Plant Dis. Rep. 41:34-41.
8. Hardison, J. R. 1962. Susceptibility of Gramineae to *Gloeotinia temulenta*. Mycologia 54:201-216.
9. Hardison, J. R. 1980. Role of fire for disease control in grass seed production. Plant Dis. 64:641-645.
10. Hyde, E. O. C. 1945. Ryegrass seed: Pre-harvest examination for blind-seed disease and estimation of germinating capacity. N.Z. J. Agric. 70:271-276.
11. Johnston, M. E. H., Matthews, D., and Harrison, S. C. 1964. The diurnal periodicity in the ejection of ascospores of *Gloeotinia* (Phialea) *temulenta* (Prill et Delacr.) Wilson, Noble, et Gray. N.Z. J. Agric. Res. 7:639-643.
12. Lithgow, A. V., and Cottier, K. 1953. Pre-harvest examination for blind-seed disease and estimation of germinating capacity. N.Z. J. Agric. 87:405-406.
13. Mantle, P. G., and Shaw, S. 1976. Role of ascospore productivity by *Claviceps purpurea* in aetiology of ergot disease in male sterile wheat. Trans. Br. Mycol. Soc. 67:17-22.
14. Neil, J. C. 1942. Blind-seed disease of rye-grass - II. N.Z. J. Sci. Technol. 24:65A-71A.
15. Snedecor, G. W., and Cochran, W. G. 1980. Statistical Methods. Iowa State University Press, Ames. 507 pp.
16. Steel, R. G. D., and Torrie, J. H. 1980. Principles and Procedures of Statistics. 2nd ed. McGraw-Hill, New York. 633 pp.